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Wetzel, C. D.; Van Kekerix, D. C.; and Wulfeck, W. H., II

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A survey of 135 Navy training course managers was conducted to determine the instructional delivery and course management techniques currently used in Navy technical schools and to assess how appropriate and acceptable microcomputer support would be in these areas. The results suggest using computers for scheduling, student tracking, and record keeping. Course managers and instructors showed great interest in using computers to make their work easier. Use of computers for stable high-volume student testing situations should be encouraged for both test administration and scoring/recording/tracking functions. In some laboratory situations, computer-based instruction (CBI) in the form of ancillary trainers would allow better utilization of student and instructor time when access to actual equipment or high cost training devices is limited. Many student entering skills (e.g., reading, mathematics, technical vocabulary) can be supplemented with commonly available CBI. Learning objectives involving drill and practice, simulation, remembering facts, and use of procedural steps occur frequently in Navy training programs, and they are particularly amenable to CBI.

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Characteristics of Navy Training Courses and Potential for Computer Support

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Characteristics of Navy Training Courses and Potential for Computer Support

C. Douglas Wetzel, Ph.D.
Donald L. Van Kekerix, Ph.D.
Wallace H. Wulfeck, II, Ph.D.

Reviewed by
Edwin G. Aiken, Ph.D.

Released by
B. E. Bacon
Captain, U.S. Navy
Commanding Officer
and
J. S. McMichael, Ph.D.
Technical Director

Navy Personnel research and Development Center
San Diego, California 92152-6800

FOREWORD

This work was funded as part of the Advanced Development project entitled Low Cost Microcomputer Training Systems (Program Element Number 63720N, Work Unit Number Z1772-ET002). The project was the result of an operational requirement promulgated by the Chief of Naval Operations (OP-987H, OP-01B7).

Two surveys of Navy technical training course managers and instructors were conducted to analyze Navy training and instructional practices. This report presents the instructional delivery and course management techniques currently used in the courses surveyed and the assessment of surveyed personnel concerning the appropriateness and acceptability of microcomputer support in these areas.

The results of the other survey, which examined the learning objectives of 245 Navy technical training courses, will be published when available. The results of the present study are primarily intended for the Department of the Navy training community.

B. E. BACON
Captain, U.S. Navy
Commanding Officer

J. S. McMICHAEL
Technical Director

SUMMARY

Background and Problem

There is a high degree of interest in using microcomputers in military training to improve instruction or to supplement limited instructor resources. An important issue for Navy training is to determine the requirements for microcomputer support in both the direct training of students and in the general management of training. One approach to this issue is to gain relief through the use of computer-based instruction (CBI) to augment the instructional staff in the delivery and management of instruction.

Objective

This survey was conducted to determine the instructional delivery and course management techniques currently used in Navy technical courses and to assess the suitability of microcomputer support in such courses.

Approach

On-site structured interviews were conducted with senior instructors or course managers of 135 Navy courses. The courses had an annual throughput of at least 400 students or had been identified as having critical shortfalls. The data were analyzed in terms of the type of school (A-school versus advanced C-&-F-schools), occupational group (electrical, mechanical, clerical, operator, and team), and course duration.

Findings

The percentage of users and average percent of time the surveyed courses devoted to different instructional methods fell into three groups: 76 percent usage (lecture and lab) for 40 percent of the time; 56 to 62 percent (tests, films or videotape, and demonstration) for 5 to 10 percent of the time; 22 to 35 percent (self-study, discussion, tutoring, drill, and practice) for 7 to 30 percent of the time. An analysis of the test methods currently employed showed the greatest use of computers for general administrative test scoring, analysis, and recording. Course managers frequently cited training objectives calling for simulation (63%) and drill and practice (54%). This result coincided with a companion analysis of actual training objectives that found the use of procedures and remembering of facts to be quite frequent. Training objectives for computer use were reported by 18 percent of the sample, while 26 percent reported that the student would use a computer on the job after completing the course.

The first ranked priority for computer support was for course managers (97%). General administrative or clerical computer support in the area of registering, scheduling, tracking, score recording, and general record keeping were cited as desirable items to add. The next ranked area for computer support included using CBI. In assessing future interest, about 27 percent of the courses nominated at least one module as suitable for CBI. Currently about 12.6 percent of all sampled courses used some form of CBI (20% in A-schools and 5.6% in C-&-F-schools). Not surprisingly, most of these were in electrical related schools (30%).

Special problems in curriculum stability (39%), inadequate learning objectives (39%), students' entering skills (33%), and students' abilities in math (35%), and reading (46%) were reported. A severe student "wait time" for access to laboratory equipment was reported by 13 percent of the course managers, with A-schools reporting a more severe

problem (20.3%) than C-&-F-schools (7%). About 14 percent of the students were reported to not reach criterion on the first attempt of a module test, with 36 percent of the managers wanting to track such test attempts and another 21 percent being dissatisfied with their current tracking process. Overall, the managers estimated that fast and slow students differed by about 8 days in completing courses.

Discussion and Conclusions

The lowest common denominator to all of the courses surveyed was the need for some general administrative and clerical computer support in the area of registering, scheduling, tracking, score recording, and general record keeping. These training management functions may become more complicated and less centralized in view of recent initiatives to move training from formal classrooms to shipboard or on-the-job training. While improvements resulting from easing clerical or administrative tedium are easy to foresee, the value of CBI applications in delivering instruction requires scrutiny. Rather than computerizing entire curricula, a more rational path is to identify selected CBI applications that do offer an improvement. Some practical reasons for using CBI were (1) offering learning capabilities not possible with conventional methods, (2) reducing costs compared to those of high fidelity trainers, (3) supplementing instructor resources, (4) standardizing instruction over many sites, (5) on-site individual training, and (6) possible reductions in training time. Severe student wait times for access to laboratory equipment could be reduced with less expensive CBI systems employed as "ancillary trainers" to teach related information or component skills pertinent to the more expensive trainers for which access is limited.

Recommendations

1. Computer support should be provided for many administrative and clerical functions such as scheduling, student tracking, and general record keeping. Student testing programs with a stable high volume would benefit from computerized test administration, scoring, recording, and tracking functions.

2. With recent initiatives to move training out of shore-based schools, training management, student record keeping, and certification testing will be more diffuse and harder to manage in the future. Therefore, stand-alone computer tools on standard microcomputers should be developed for shipboard personnel to use in managing training.

3. CBI should be used for a number of specific applications. Using ancillary trainers for some laboratory situations would allow better utilization of student and instructor time when limited access to high cost trainers causes excessive waiting. Many students' entering skills (e.g., reading, mathematics, technical vocabulary) should be supplemented with commonly available CBI. Learning objectives involving drill and practice, simulation, remembering facts, and use of procedural steps occur frequently and are particularly amenable to CBI.

4. Continuing work should be supported to develop guidelines as to when CBI is appropriate and to develop aids for CBI authors so that they can develop quality CBI for their students.

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INTRODUCTION

Problem and Background

The current high interest in using microcomputers in military training reflects the general increase in use of computers in our society and their use in education to improve instruction or supplement limited instructor resources. An important problem for Navy training personnel is to determine what requirements exist for microcomputer support in both the direct training of students and in the general management of training. To do this requires a better understanding of the kinds of training that are most amenable to computerization, the software available to meet these requirements, and the requirements that available software does not meet. A variety of individual evaluations indicate that various forms of computer-based instruction (CBI) can make good gains in efficiency and effectiveness for some kinds of training (Bangert-Drowns, Kulik, & Kulik, 1985; Blaiwes & Regan, 1986; Fletcher & Rockway, 1986; Kearsley, 1983; Orlansky & String, 1981). However, there is no general strategy to guide investments in automation in training or to project system requirements for the future. Accordingly, the delivery and management techniques used in Navy technical schools as well as appropriateness and acceptability of microcomputer support in these areas need to be assessed.

The increased complexity of current and projected Navy equipment places additional demands on the Navy training establishment to provide the skilled operators and maintainers the Fleet needs to achieve operational readiness. This increases the need for senior technicians and operators to staff the schools. At the same time, the growth of the Navy has increased the Fleet needs for experienced personnel to provide supervision and leadership for the new units. School staffs may not grow to match the increased demand, but will have to train more students with equal or reduced staffing. Recent initiatives to move training from shore-based schools to ships will make training and training management even less centralized and harder to manage in the future.

Computer-aided instruction (CAI) and computer-managed instruction (CMI) may be used to augment the instructional staff in the delivery and management of instruction. In CAI, computers actually deliver the instruction. Many interactive CAI sequences present new information to students and then query their understanding. Tailored branching directs students who answer incorrectly to remedial or explanatory tracts. Other situations may involve simulation of principles not easily conveyed in conventional book form or practice on procedural steps such as the operation of equipment. In CMI, computers manage instruction rather than deliver the actual instruction. Computers are used to automate many clerical aspects of record keeping; for example, scheduling of resources, students, and instructors; preparing reports; and keeping track of student information such as class rosters, test scores (perhaps scoring tests and providing feedback), and student progress over course modules. Often, the general term CBI is used to represent either CAI or CMI or both.

Neither CAI nor CMI should be viewed as a panacea by the naval education and training community. Not all instruction is appropriate for CAI (Montague & Wulfeck, 1984). Selection guidelines must be developed in order to identify the Navy schools that are suitable for CAI and/or computerized course management.

Purpose

This survey was conducted to determine the instructional delivery and course management techniques currently used in Navy technical courses and to assess the suitability of microcomputer support in such courses.

APPROACH

Sample Selection

The Navy maintains over 4800 courses of instruction, most of which graduate less than 100 students a year. Since converting lecture-based instruction to some form of CBI requires substantial resources (Van Kekerix, Wulfeck, & Montague, 1982), many of these schools lack the manpower to implement CBI. Therefore, only the managers and senior instructors of courses with an annual throughput of 400 or more students (i.e., large enough to support a transition effort) were interviewed. With large student throughput, the costs of computerization can be amortized over a large number of students making for greater cost efficiencies. However, Van Kekerix, Wulfeck, and Montague (1982) showed that CBI can avoid substantial costs even for courses with very few students.

Courses with an annual throughput of 400 students were extracted from the Navy Integrated Training Resources and Administration System (NITRAS) data base maintained by the Naval Education and Training Command (NAVEDTRACOM). Submarine courses were not included in this initial selection at the request of the Chief of Naval Education and Training (CNET). The initial selection was augmented with courses of shorter duration for the 32 technical ratings Koehler (1982) identified as facing critical personnel shortfalls through FY87. These "critical" courses especially need assistance to enhance the performance of schoolhouse personnel. The initial selection process resulted in a total of 340 candidate courses for the survey.

The 340 candidate courses were reduced by: (1) the Chief of Naval Technical Training (CNTT) limiting the number of courses that could be surveyed at a single command, (2) dropping courses being revised or discontinued, (3) financial constraints that limited travel to sites with at least five courses, and (4) four course managers who each addressed all of the courses they controlled in a single interview.

The final survey consisted of 135 course managers and senior instructors, who were interviewed from 1983 through 1984.

Survey Questionnaire

The survey questionnaire was developed in conjunction with the NAVEDTRACOM Training Analysis and Evaluation Group (TAEG)[1] to obtain information related to the suitability, desirability, and acceptability of CAI and CMI. The questionnaire (Appendix A) was administered as an on-site structured interview with course managers or senior instructors. The questions formed clusters focusing on specific areas of instructional formats, instructional content, student problems, training objectives, testing, managerial functions, and the amount of time spent in the various instructional activities. Other details of the questionnaire and the rationale for its development are contained in a draft paper by Terrell and Aagard.[2]

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[1] Now Naval Training Systems Center, Code 10.

[2] W. R. Terrell & J. Aagard, J. (1983, December). A computer data base and procedure for determining the amenability of Navy technical training courses to computer based instruction (Draft technical report). Orlando, FL: Training Analysis and Evaluation Group (TAEG).

Data Analysis

The survey responses were summarized in terms of frequencies, percentages, and averages. The data were sorted by type of school (A-school or advanced C-&-F-schools), occupational group (electrical, mechanical, clerical, operator, and team), and course duration. Not all statistics derived from these sorts are reported due to the large volume and/or small sample sizes resulting from some breakdowns. Table 1 presents a breakdown of the number of responses according to the sorting dimensions. Appendix B lists the individual course titles by occupational group.

Table 1

Sample Frequencies by Type of School, Occupational Group, and Course Duration

Category	Sample Frequencies						
	Occupational Group						
	Electrical	Mechanical	Clerical	Operator	Team	Other	Total
Type of School							
A	17	20	11	14	0	2	64
C-&-F	3	9	29	12	17	1	71
Total	20	29	40	26	17	3	135
Course Duration							
1-5 days	0	1	15	7	17	1	41
6-20 days	4	8	13	4	0	2	29
21-40 days	2	8	5	3	0	0	20
41-80 days	6	11	7	5	0	0	29
81+ days	8	1	0	7	0	0	16
Total	20	29	40	26	17	3	135
	Course Duration (days)						
	1 to 5	6 to 20	21 to 40	41 to 80	81+	Total	
Type of School							
A	1	7	15	27	14	64	
C-&-F	40	22	5	2	2	71	
Total	41	29	20	29	16	135	

Note. See Appendix B for a complete list of survey courses.

SURVEY FINDINGS

Course and Student Characteristics

Tables 2, 3, and 4 present course and student characteristics by type of school, occupational group, and course duration respectively. A-school course managers reported about twice as many modules per course as did C-&-F-school managers, reflecting the generally longer duration of A-schools. These longer duration courses were in the operator, electrical, and mechanical occupational groups. The number of modules a course contains indicates the scope of effort a major course revision would entail. Since a few courses divided modules into many small segments, both the median (middle score when ranked) and the arithmetic mean for number of modules are reported.

Tables 2, 3, and 4 also present the average number of students and instructors for both classrooms and laboratories. Classroom student/instructor ratios differed very little across the sample, except for the large ratio for team (training) schools (Table 3). The ratios can reflect the cost effectiveness for individual courses and, where appropriate, may also indicate a need to use CBI to compensate for instructor shortfalls.

A relatively small percentage of courses in the total sample (12.6%) currently use CBI. A-schools were four times as likely as C-&-F-schools to use CBI. Among the occupational groups, the most frequent use of CBI was in the electrical group. Over half of the CBI use was in schools of greater than 40 days in duration. Both the mean and median number of modules using CBI are reported. Again the number of modules depends upon how the courses divided their material. The 17 courses currently using CBI (listed in Appendix C) used the following computer equipment[3] at the time of the survey: Apple, TRS-80, and DEC Rainbow.

Courses presently using computers in individual elements of the instruction or course management might be strong candidates for CBI consideration. However, the incompatibility of courseware or management software programmed in different computer languages for differing computers would require detailed case-by-case analysis. At the time these survey data were collected, contracts for "Navy standard" microcomputers were just coming into effect; therefore, none of the surveyed courses used any of these machines. Since that time, four Navy standard microcomputers have become available--none of them totally compatible with each other.

Student Scheduling

Tables 2, 3, and 4 present the average number of working days students waited before the start of a course; that is, holding time. The percentage of course managers reporting some holding time was 30 percent overall (N=40) and 55 percent for A-schools, and was largest for long duration schools. Overall, course managers reported about a week's holding time for courses that had other than zero or "no wait." These tended to be longer duration A-school courses in the electrical, mechanical, and operator occupational groups. Courses with long average holding times for students might use some form of CBI for course-relevant pretraining, remediation, enrichment, or other form of individualization.

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[3]Identification of the equipment is for documentation only and does not imply any endorsement.

Table 2

Course and Student Characteristics by Type of School

Questionnaire Item	Course Managers' Responses A-School N = 64	C-&-F-School N = 71	Total N = 135
Number of modules in course			
Mean	25.4 (62)	11.3 (48)	19.2 (110)
Median	12.5 (62)	6.5 (48)	9.5 (110)
Number in average classroom			
Students	26.8 (62)	28.4 (69)	27.6 (131)
Instructors	1.3 (62)	1.5 (69)	1.37 (131)
Student/instructor ratio	22.1 (62)	23.2 (69)	22.7 (131)
Number in average laboratory			
Students	21.5 (56)	29.7 (59)	25.7 (115)
Instructors	3.4 (56)	2.9 (59)	3.15 (115)
Student/instructor ratio	9.7 (56)	11.4 (59)	10.6 (115)
Percent of courses using CBI	20.3% (13)	5.6% (4)	12.6% (17)
Number of modules using CBI			
Mean	28.7 (13)	8.0 (4)	23.8 (17)
Median	9.0 (13)	3.5 (4)	7.0 (17)
Student "holding time" prior to course			
Percent of courses	55% (35)	7% (5)	30% (40)
Average number of working days	6.2 (35)	4.8 (5)	6.03 (40)
Percent of courses with severe student "wait time" for access to laboratory equipment	20.3% (13)	7.0% (5)	13.3% (18)
Average percent students reaching module test criterion on first attempt	83.3% (52)	90.1% (40)	86.2% (92)
Average days completion time for			
FAST students	58.9 (57)	17.8 (42)	41.43 (99)
SLOW students	70.9 (57)	20.1 (42)	49.36 (99)
Difference	12.04	2.36	7.93

Notes.

1. N = total number of course managers per type of school.

2. Averages are arithmetic means, except for skewed distributions where medians (midpoints) are also provided.

3. The actual number of course managers who responsed is provided in parentheses after the response.

Table 3

Course and Student Characteristics by Occupational Group

Questionnaire Item	Course Managers' Responses				
	Electrical N = 20	Mechanical N = 29	Clerical N = 40	Operator N = 26	Team N = 27
Number of modules in course					
Mean	20.4 (19)	16.9 (22)	13.4 (34)	35.7 (23)	4.9 (10)
Median	12.0 (19)	10.5 (22)	7.0 (34)	12.0 (23)	4.5 (10)
Number in average classroom					
Students	25.5 (19)	22.7 (29)	28.9 (40)	24.1 (26)	42.0 (16)
Instructors	1.4 (19)	1.2 (29)	1.5 (40)	1.2 (26)	1.6 (16)
Student/instructor ratio	18.9 (19)	21.1 (29)	21.5 (40)	21.9 (26)	34.6 (16)
Number in average laboratory					
Students	18.9 (17)	20.6 (27)	22.9 (29)	23.1 (24)	47.3 (17)
Instructors	2.8 (17)	2.7 (27)	2.2 (29)	4.8 (24)	3.1 (17)
Student/instructor ratio	8.7 (17)	9.0 (27)	13.3 (29)	8.8 (24)	13.1 (17)
Percent of courses using CBI	30% (6)	3.4% (1)	7.5% (3)	15.4% (4)	11.8% (2)
Number of modules using CBI					
Mean	9.3 (6)	16.0 (1)	5.0 (3)	74.8 (4)	5.0 (2)
Median	8.0 (6)	16.0 (1)	2.0 (3)	16.0 (4)	2.5 (2)
Student "holding time" prior to course					
Percent of courses	40% (8)	62% (18)	12.5% (5)	31% (8)	0% (0)
Average number of working days	10.1 (8)	4.7 (18)	4.6 (5)	6.3 (8)	- (0)
Percent of courses with severe student "wait time" for access to laboratory equipment	25.0% (5)	10.3% (3)	12.5% (5)	15.4% (4)	0% (0)
Average percent students reaching module test criterion on first attempt	79.2% (14)	90.9% (27)	88.2% (23)	79.9% (21)	97.4% (5)
Average days completion time for					
FAST students	87.2 (17)	37.4 (27)	22.0 (27)	51.2 (20)	3.2 (6)
SLOW students	95.8 (17)	42.9 (27)	25.6 (27)	66.9 (20)	3.2 (6)
Difference	13.1	5.4	3.6	15.7	0.0

Notes.

1. N = total number of course managers per occupational group.

2. Averages are arithmetic means, except for skewed distributions where medians (midpoints) are also provided.

3. The actual number of course managers who responsed is provided in parentheses after the response.

Table 4

Course and Student Characteristics by Course Duration

Questionnaire Item	Course Managers' Responses 1-5 days N = 41	 6-20 days N = 29	 21-40 days N = 20	 41-80 days N = 29	 81+ days N = 16
Number of modules in course					
Mean	5.5 (28)	16.8 (20)	18.9 (19)	18.9 (28)	49.1 (15)
Median	5.0 (28)	10.0 (20)	11.0 (19)	13.0 (28)	13.0 (15)
Number in average classroom					
Students	33.2 (39)	28.6 (29)	25.2 (19)	24.1 (28)	21.6 (16)
Instructors	1.6 (39)	1.4 (29)	1.4 (19)	1.2 (28)	1.1 (16)
Student/instructor ratio	26.2 (39)	22.4 (29)	19.7 (19)	21.8 (28)	20.8 (16)
Number in average laboratory					
Students	36.0 (34)	23.9 (22)	21.8 (16)	20.4 (27)	19.0 (16)
Instructors	2.7 (34)	3.6 (22)	3.1 (16)	2.4 (27)	4.9 (16)
Student/instructor ratio	12.6 (34)	8.9 (22)	11.7 (16)	10.8 (27)	7.1 (16)
Percent of courses using CBI	7.3% (3)	10.3% (3)	5.0% (1)	13.8% (4)	37.5% (6)
Number of modules using CBI					
Mean	4.0 (3)	13.0 (3)	9.0 (1)	12.75 (4)	49.0 (6)
Median	5.0 (3)	16.0 (3)	9.0 (1)	6.50 (4)	8.0 (6)
Student "holding time" prior to course					
Percent of courses	2.4% (1)	10% (3)	50% (10)	45% (13)	81% (13)
Average number of working days	5.0 (1)	8.6 (3)	3.9 (10)	5.7 (13)	7.5 (13)
Percent of courses with severe student "wait time" for access to laboratory equipment	7.3% (3)	3.5% (1)	25% (5)	20.7% (6)	18.8% (3)
Average percent students reaching module test criterion on first attempt	95.1 (21)	91.7 (20)	88.8 (16)	81.6 (23)	67.1 (12)
Average days completion time for					
FAST students	3.5 (23)	31.7 (20)	25.4 (17)	58.0 (25)	107.4 (14)
SLOW students	3.5 (23)	35.6 (20)	28.5 (17)	71.3 (25)	130.6 (14)
Difference	0	3.9	3.1	13.3	23.1

Notes.

1. N = total number of course managers per course duration category.

2. Averages are arithmetic means, except for skewed distributions where medians (midpoints) are also provided.

3. The actual number of course managers who responsed is provided in parentheses after the response.

About 13 percent of the course managers reported a severe student "wait time" for access to laboratory equipment. A-school course managers reported a much higher severity of this problem (20.3%) than did C-&-F-course managers (7%) with the greatest percentage reported for electrical schools and long duration courses (Tables 2, 3, and 4). Severe wait times for equipment in some laboratories might be remedied with more efficient computerized scheduling of student activities. In others, less expensive CBI systems might be employed as "ancillary" or auxiliary trainers to teach related information or component skills pertinent to the more expensive trainers for which access is limited. For example, a videotape introduction might give waiting students an overview or summary of procedural steps or they could receive componential practice on the effects of testing points in a circuit.

Student Progress

Courses in which a substantial number of students are set back or do not reach criterion on the first attempt complicate student management. Students in these courses may require additional instructional delivery and more individual attention. Therefore, these courses are good candidates for both CMI and CAI, particularly for individualized remediation programs. In the total course sample, 86 percent of the students reached criterion on first attempt; the lowest percentage was 79 percent for the electrical and operator schools; and the highest, 97 percent for team schools. A somewhat lower percentage of students reached criterion on module tests on the first attempt in A-schools (83%) than in C-&-F-schools (90%). The lower success of students in the electrical and operator courses was associated with longer duration courses.

Courses in which there is a disparity between completion times for "fast" and "slow" students are also good candidates for CBI such as management, or remedial or enrichment programs. Overall, the difference in completion times between fast and slow students was about 8 days. This difference was largest (13-15 days) in electrical and operator A-school courses and increased with course duration (Tables 2, 3, and 4).

Instructional Methods Employed

The instructional media profile of a course indicates how complex the course is to manage and to convert to CBI. Table 5 presents the instructional methods employed by our course sample in terms of the percentage of the 135 courses that use each instructional method and the estimated percentage of time that the courses using each instructional method actually devote to this method. The surveyed courses fall into three groups: 76 percent usage (lecture and lab) for 40 percent of the course time, 56 to 62 percent usage (test, films or videotapes, and demonstration) for 5 to 10 percent of course time, 22 to 35 percent (self-study, discussion, tutoring, and drill and practice) for 7 to 30 percent of course time.

Figure 1 presents these data by type of school and occupational group. The A-schools use laboratories, tests, and tutoring more; while the C-&-F-schools use lectures more. When broken down by occupational group, the team courses are notable in not using tests, self-study, or tutoring. For those courses actually using an instructional method, the percent of time devoted to self-study is higher for A-schools, while the C-&-F-schools devote more course time to discussion and drill and practice. With the exception of demonstrations in team courses, all of the courses spend less than 10 percent of course time on tests, films or videotapes, demonstrations, and tutoring. Electrical and clerical groups appear to devote more time to self-study and discussion more than other groups.

Table 5

Instructional Methods Used by Surveyed Courses

Instructional Method	Surveyed Courses Using Method (%)	Estimated Time Using Method (%)
Lecture	76	40
Laboratory	76	40
Tests	62	9
Films or videotapes	58	5
Demonstrations	56	10
Self-study (print materials)	35	30
Discussions	33	27
Tutoring	30	7
Other (drill & practice)	22	26

Note. N = 135.

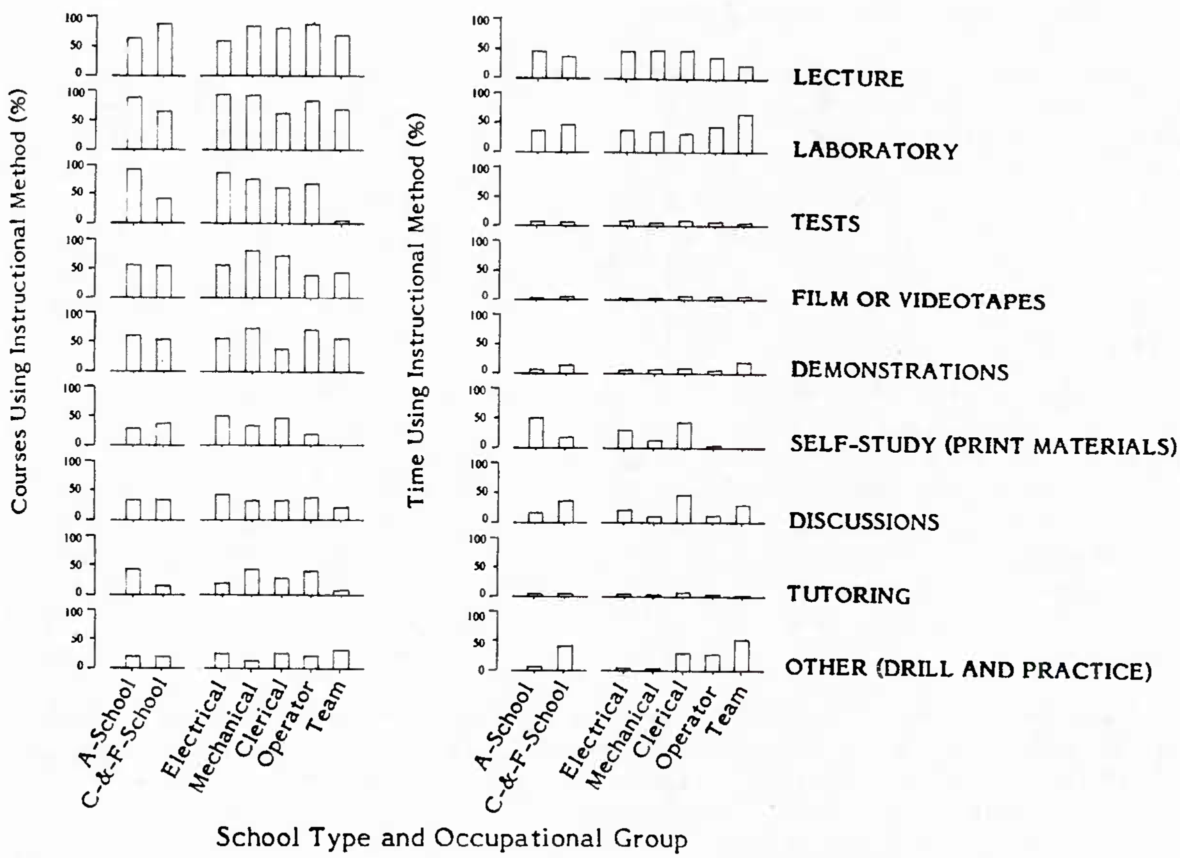

Figure 1. Use of instructional methods by school type and occupational group.

Many of the instructional methods in Table 5 and Figure 1 can be converted to CBI. Procedures or steps that are used frequently are often simulated in laboratories. Examples of applications amenable to CAI techniques are videodisc presentations of equipment to be operated or diagnosed during malfunction; administration and scoring of tests, which are common to many of the courses; and, when student throughput is large enough, combining material currently in films or videotapes with computer graphics in an interactive videodisc presentation that allows branching based upon student responses. Drill and practice can be easily automated, because it involves repetitive presentation of well defined to-be-remembered items or knowledge tests. (The response percentages shown for drill and practice may not be entirely accurate because respondents identified it in the "other" catogory.)

Learning Objectives

Table 6 ranks the instructional approach called for by the learning objectives of the courses surveyed in terms of the percentage of courses requiring that approach. The instructional approaches form two groups of "high" (49-63%) and "low" (18-20%) requirements. Figure 2 shows these responses broken down by school type and occupational group.

1. Simulation. The high percentage of courses requiring simulation reflects the large number of laboratories with high fidelity training devices, interactive scenarios with a complex catalog of consequences, manipulative models, etc. Accordingly, a high percentage of mechanical, operator, and team courses require simulation. As noted previously, this finding suggests an application for CBI.

2. Human interaction. Modules within a course requiring human interaction (i.e., teams, discussion groups, scenario role playing, etc.) were most frequent for team occupations, with other groups reporting lower percentages. Generally, such human interaction is not considered suited for CAI, but it would be applicable for computer-based tracking of student progress and maintaining course records. CAI could be used for video re-enactments of team situations with stop points to question an individual learner about courses of actions at important team interaction/sequence points. Team situations involving electrical or audio communication (not face-to-face) might also be simulated in CAI.

3. Extensive drill and practice. Learning objectives requiring drill and practice were most frequently cited by operator and team course managers. Many types of drill and practice material are particularly good candidates for application of CBI as, for example, when drill and practice is so extensive or responses so precise that the student-instructor ratio or human patience make the traditional classroom setting impractical. Drill and practice can include memorizing extensive or complex knowledge bases or repeating or performing procedures with equipment, team situations, and other job sequences that require the learners to repeat procedures until they become well practiced.

4. Variable responses. The term "variable response" refers to complex responses that vary according to the context of the interaction. A situation may involve complex "if-then" relations that do not always have a required order or sequence for performing the task. The resulting large number of possible action sequences may make cataloging a set of fixed responses impractical. For example, many equipment problem solving situations require variable solution paths. Another example would be with many combat information center (CIC) or antisubmarine-warfare (ASW) team situations, where, for

Table 6

Learning Objective Requirements

	Responses (%)		
Do the Learning Objectives Require:	Yes	No	NA[a]
Simulation	63	35	2
Human interaction	61	39	0
Extensive drill and practice	54	43	3
Variable responses	49	51	0
Automated cues and prompts	20	76	4
Computer utilization	18	81	1

Note. N = 135.

[a]NA = not applicable.

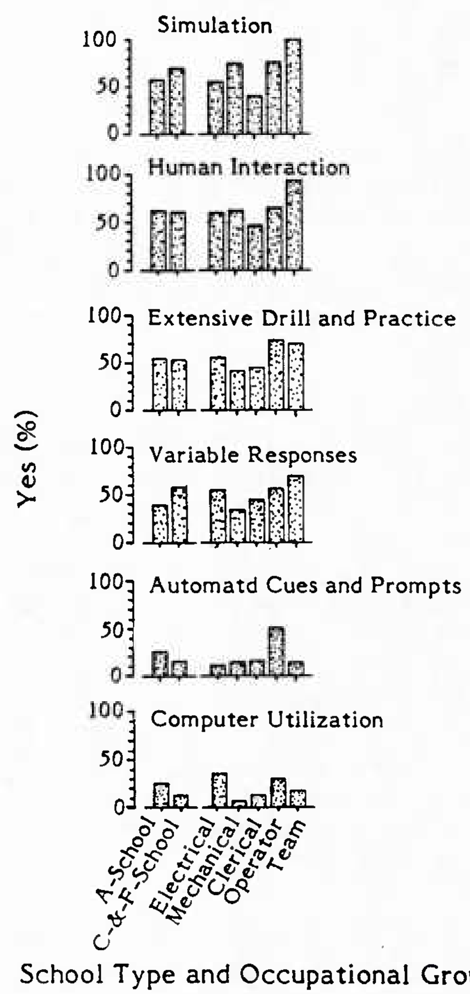

Figure 2. Learning objective requirements by school type and occupational group.

example, one person errs and another makes a compensatory move leading to a correct solution. Modules within a course requiring variable responses are not easily programmed for CAI, but computer-based management may be used for tracking and keeping course records.

5. Automated cues and prompts. Course modules requiring automated cues and prompts were most frequently cited by operator courses and infrequently by others. The selection of CAI simulation should be considered for course modules involving interaction with automated equipment in which the operator has little or no control over the occurrence of events or their input rate. Often the operator is also subject to additional requirements by other persons as a consequence of the nature or rate of the operator's responses. For example, the rate at which a Naval Tactical Data System tracking operator updates a track depends on the system latency and the number of commands in the queue. The number of commands will be affected by the input from other consoles in the system and voice channel requests for information.

6. Computer utilization. Learning objectives requiring computer utilization were most frequently cited by managers of electrical and operator A-school courses. Modules requiring a computer for computations, information retrieval, or other similar problem-solving techniques suggest an amenability with CAI. Other uses are related to the same issues discussed for automated cues and prompts.

Test Methods

Responses about the test methods employed by the courses are separated in Table 7 according to whether the existing test methods are computerized, manual, or not applicable. These in turn are subdivided according to whether the course managers were satisfied (OK) or were not satisfied (NO) with the test methods. Figure 3 presents the use of test methods by school type and occupational group as well as whether the course managers considered the test method inadequate and adequate. (Some of the sample sizes are quite small.)

In general, manual test methods are used far more frequently than computer methods, and course managers' satisfaction outweighs dissatisfaction.[4] Where computers are used, satisfaction seems to outweigh dissatisfaction, although this is also true of the manual methods.

The greatest current use of computers is for general administrative test scoring, analysis, and recording. Figure 3 shows the highest usage of computer testing is by A-schools and the electrical and mechanical occupational groups. The electrical group also used computerized test methods more often than other test methods. Courses requiring a significant number of instructional man-hours for test scoring, test analysis, and test recording usually are amenable to CBI. Courses that require extensive testing or maintain substantial test item banks are excellent applications of CMI. Constant test availability and the ability to systematically or randomly generate alternate test forms are some of the benefits associated with automating test processes.

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[4]This finding is generally confirmed when the course managers' satisfaction and dissatisfaction with each test method are calculated separately for computer and manual test methods. See Table D-1.

Table 7

Test Methods Employed

Test Methods Used	Responses (%) Computer OK	Computer NO	Manual OK	Manual NO	Want[a] to Add	NA[b]
Performance evaluation	9	3	60	13	0	16
Pretesting	9	2	16	14	6	53
Unit/module tests	11	1	40	16	1	31
Summary/final tests	7	1	33	15	1	43
Remediation prescription	7	1	27	13	1	50
Test item bank	5	1	34	16	4	39
Test scoring	16	5	28	18	1	32
Test analysis	15	8	20	16	1	39
Recording	16	4	32	23	1	24

Notes.

1. Percentages do not always total 100 due to rounding.
2. See Table D-1 for alternate calculations of satisfaction and dissatisfaction with each test method.

[a]Course manager would like to add a test method not currently employed.

[b]NA = not applicable.

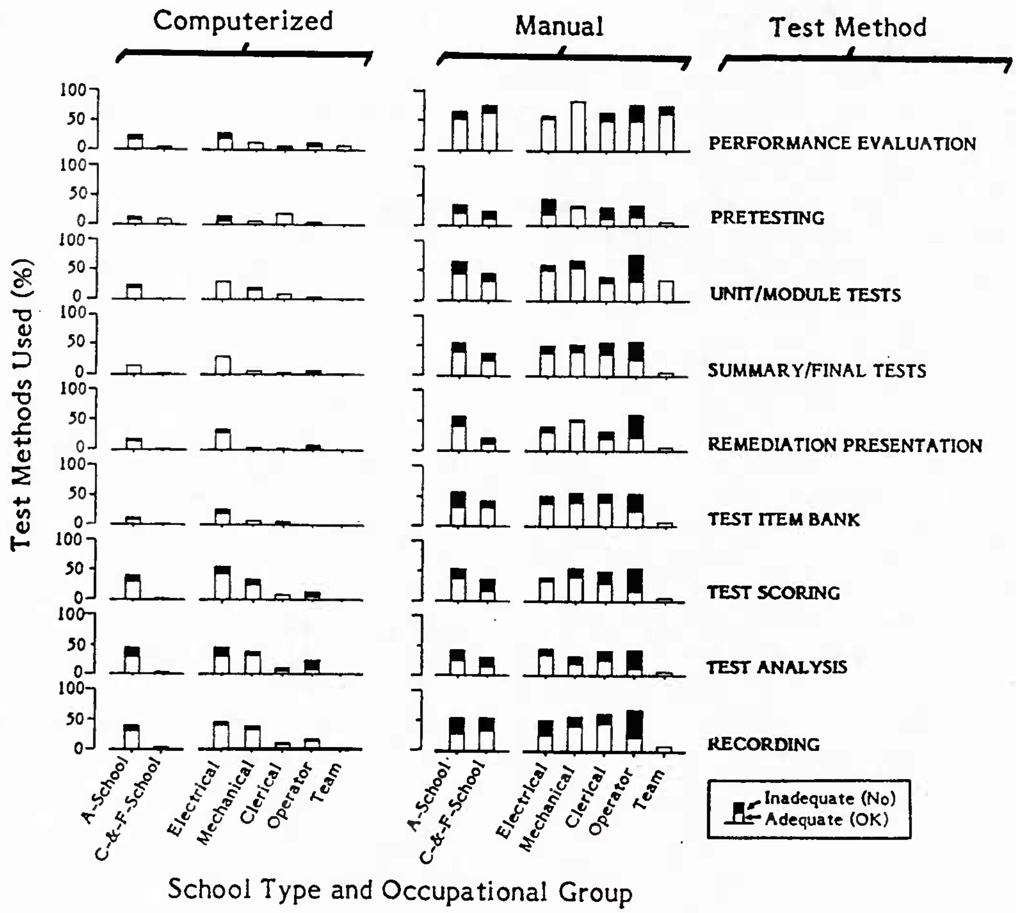

Figure 3. Test method use by school type and occupational group.

Many of the courses that prescribe remedial assignments for each student according to a diagnosis of test results should also be amenable to CMI. The largest percentages of not-applicable responses were for pretesting and remediation prescription (about 50%), as well as for final tests, item banking, and test analysis (about 40%); all indicate methods simply not employed at present.

Table 7 shows that 60 percent of the course managers were satisfied with the existing manual (noncomputerized) test method of "performance evaluation." A heavy emphasis on evaluating real performance in laboratories suggests that computerized performance testing must offer an improvement to top this satisfaction with existing techniques. Performance evaluations, which would benefit from electrical scoring and/or recording with performance reports shown alphanumerically and/or graphically, suggest CMI should be considered.

Special Course Problems

Special problem areas identified by the course managers are shown in Table 8 and Figure 4. The "yes" responses in the table fall in the relatively narrow range of 33 to 46 percent.

Overall, 39 percent of the course managers reported inadequate learning objectives. This was more characteristic of C-&-F-schools than A-schools. Inadequate terminal and/or enabling objectives indicate that a substantial course revision may be needed before investing in CBI; however, this revision would be a good opportunity for using CBI. Inadequate objectives would include objectives that do not specify desired behavior, present insufficient content scope and depth, or have an imbalance in the types of objectives (e.g., too few recall-fact objectives in relation to the number of use-unaided procedure objectives; cf., Montague, Ellis, & Wulfeck, 1983).

Thirty-nine percent of the course managers reported curriculum stability as a special problem area. Curriculum instability refers to dynamic subject matter where lesson content changes constantly (e.g., because of new equipment). Updating subject matter for CBI would require special consideration when a course adds brand-new subject matter.

A large number of students entering a course without prerequisite skills suggest the need to develop remedial programs to correct the deficiencies. CBI should be considered as a vehicle for diagnosing the need and providing the remedial programs. Likewise, the specific deficiencies in reading and math (slow progress, repeated test failures, and excessive requirements for tutoring) suggest the need for an alternate instructional program or remediation. CBI should be considered as a vehicle for meeting the special needs of students with low reading and math level scores. Figure 4 shows that these problems are generally more prevalent in A-schools and in electrical, mechanical, and, to a lesser extent, operator occupational groups. While overall 1/3 to 1/2 of the course managers reported these special problems, only 3 percent (four courses) assign special materials based on aptitude scores (discussed later). This finding suggests that individualized remediation is not currently very prevalent, but has the potential for substantial improvement. CBI offers the potential for individualization, self-pacing, and program-controlled branching to special content or repetition based on a student's response.

Table 8

Special Course Problem Areas

Special Problem Areas	Responses (%) Yes	No	NA[a]
Adequate learning objectives	39	58	3
Curriculum stability	39	60	1
Student entering skills	33	63	4
Student math ability	35	59	7
Student reading ability	46	53	1

Notes.

1. N = 135.
2. Percentages do not always total 100 due to rounding.

[a]NA = not applicable.

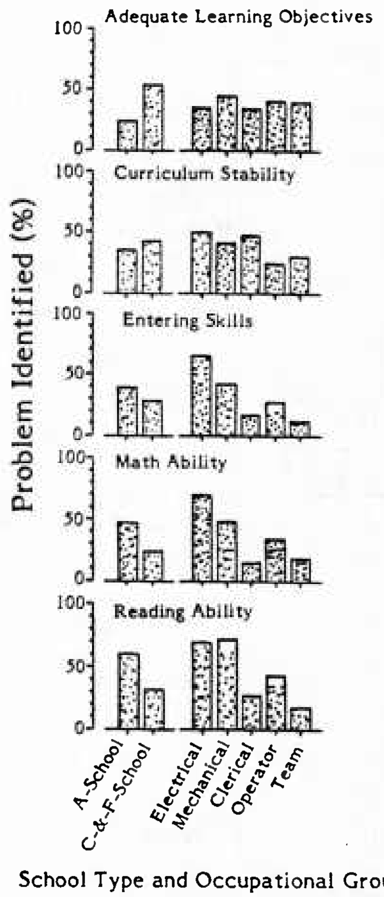

Figure 4. Special course problem areas by school type and occupational group.

Achievement Distribution

Table 9 shows the distribution of student achievement as perceived by the course managers. For this question, the respondents were asked to characterize their students' achievement by choosing one of three student ability ratings (below-average, average, above-average) or not applicable. In the total sample, about half of the course managers judged the students' achievement to be average with more citing "above" than "below" average. The A-schools cited more below-average student achievement than the C-&-F-schools, where more above-average achievement was reported. By occupational group, about half of the team course managers (9) reported that rating student achievement was not applicable. The largest number of below-average ratings was in the operator group and the largest number of average ratings was in the electrical and mechanical groups. Individual courses with average or below average achievement distributions, high attrition and setback rates, and low reading and math scores might be candidates for remedial instruction. For above-average students, enrichment might be appropriate. Many basic skills remediation and enrichment situations would be amenable to CBI because this type of instruction is widely available in the general world of education.

Table 9

Perceived Distribution of Student Achievement by School Type and Occupational Group

		Student Achievement (%)			
Category	n[a]	Below Average	Average	Above Average	NA[b]
Occupational Group					
Electrical	(20)	10 (2)	65 (13)	25 (5)	0 (0)
Mechanical	(29)	7 (2)	62 (18)	31 (9)	0 (0)
Clerical	(40)	8 (3)	45 (18)	35 (14)	13 (5)
Operator	(26)	19 (5)	42 (11)	31 (8)	8 (2)
Team	(17)	0 (0)	12 (2)	35 (6)	53 (9)
School Type					
A-schools	(64)	16 (10)	56 (36)	27 (17)	2 (1)
C-&-F-schools	(71)	6 (4)	37 (26)	35 (25)	23 (16)
Total Sample	(135)	10 (14)	46 (62)	31 (42)	13 (17)

Notes.

1. The actual number of responses is given in parentheses after the response percentages.

2. Not all percentages total 100 due to rounding.

[a]n = Total number of course managers per category.

[b]NA = not applicable.

Use of Aptitude Scores

Only four A-school course managers (3%) assigned their students special materials based on aptitude scores: (1) Operations Specialist A (A221-0011) using Gates-MacGinitie Reading Test, (2) Academic Remedial Training (A950-0061) using Gates-MacGinitie Reading Test, (3) Job-oriented Basic Skills, Operations Strand II (A100-0059) using Armed Services Vocational Aptitude Battery (ASVAB) and Gates-MacGinitie Reading Test, and (4) Job-oriented Basic Skills, Electrical Strand IV (A100-0060) using ASVAB and Gates-MacGinitie Reading Test. Courses assigning special materials to students based on their aptitude scores are good candidates for CBI if they teach basic skills such as technical or general vocabulary, reading, and mathematics.

Computer Use

Twenty-six percent (N=35) of the course managers said their students would use a computer on the job after completing this course; 73 percent (N=99) said they would not (1%, N=1 said not applicable). Figure 5 shows that three to four times as many A-school as C-&-F-school course managers answered that their students would use computers. Electrical and operator schools were prominent in on-the-job computer use. The pattern of the responses to this question is quite similar to that shown for the learning objective of computer utilization (see Figure 2). However, the response percentages for the learning objective question in Figure 2 were generally less than those for the present on-the-job use question (7% overall; 15.6% for A-schools; 0% for C-&-F-schools). If course graduates will use a computer in their work, consideration should be given to training them with computers. Training for computer use on the job can be amenable to CBI.

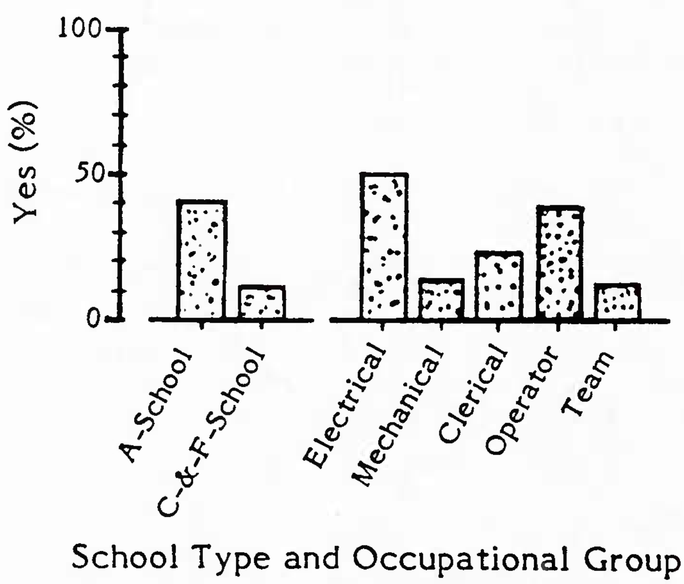

Figure 5. Student use of computers on the job after completing course.

Of the 135 course managers, 55 responded to the question, "What modules in the course should be considered a high priority for some form of computer-assisted instruction?" and 27 percent (N=37) nominated at least one module as suitable for CBI (Table 10). The specific type of modules nominated were mostly for remediation, testing, and management functions.

Table 10

High Priority Modules for Computer-assisted Instruction

Categorized Responses	Number of Responses
Nominated at least one module	37
Wanted remediation in math and reading	5
Wanted test administration and processing	4
Indicated management functions, like record keeping and student registration and scheduling	7
Develop "computer literacy"	2
Total	55

At the end of each questionnaire, respondents were asked the open-ended question, "If computer support was available for your school, what functions would have first priority?" They cited the following three functions most frequently:

1. Computer support for course managers (97%).

2. Computer-based drill and practice, test scoring and recording, and student tracking (90%).

3. Computer-based simulation and/or position training[5] (68%).

Again, these response percentages show that course management and recording, tracking, drill and practice, and simulation were all clearly of high interest to the course managers. Computers are viewed more as instructional and managerial support devices than as primary instructional systems.

Adequacy of Course Management

Responses about the use of three management processes are separated in Table 11 into existing computer or manual test methods, which are subdivided according to whether or not the course managers are satisfied (OK and NO). The course managers responded

[5] Position training is usually associated with team training and concerns the training of individual operator skills for a station in the team situation.

most frequently that they wanted to add a management method or that they were satisfied with the existing manual method. In general, the satisfaction outweighed the dissatisfaction for each of the two methods. This finding is generally confirmed when the course managers' satisfaction with their course management process is calculated separately for computerized and manual management processes. See Table D-2.

Table 11

Course Management Processes

Management Processes Used	Responses (%)					
	Computer		Manual		Want to Add	NA[a]
	OK	NO	OK	NO		
Student time/test-attempt records	5	2	36	19	36	2
Student scheduling	16	7	30	10	36	1
Resource scheduling	7	4	44	16	28	1

Notes.

1. N = 135.

2. See Table D-1 for alternate calculations of satisfaction and dissatisfaction with the present course management process.

[a]NA = not applicable.

Figure 6 shows the responses from Table 11 by school type and occupational group as well as whether the course managers considered their management process inadequate and adequate. (Some of the sample sizes have become small.) Figure 6 shows that computerized management is not widely used although A-schools use it more than C-&-F-schools; their use of manual methods is about the same. Likewise, electrical and mechanical courses use more computers than the other groups.

Computers can easily automate the management processes of record keeping and tracking of student progress. Courses that would benefit from a record of student instruction time, time in tests, test attempts, and automated scoring and tabulation should be amenable to CMI. Some of this information could also be used online during CAI to provide feedback to the learner.

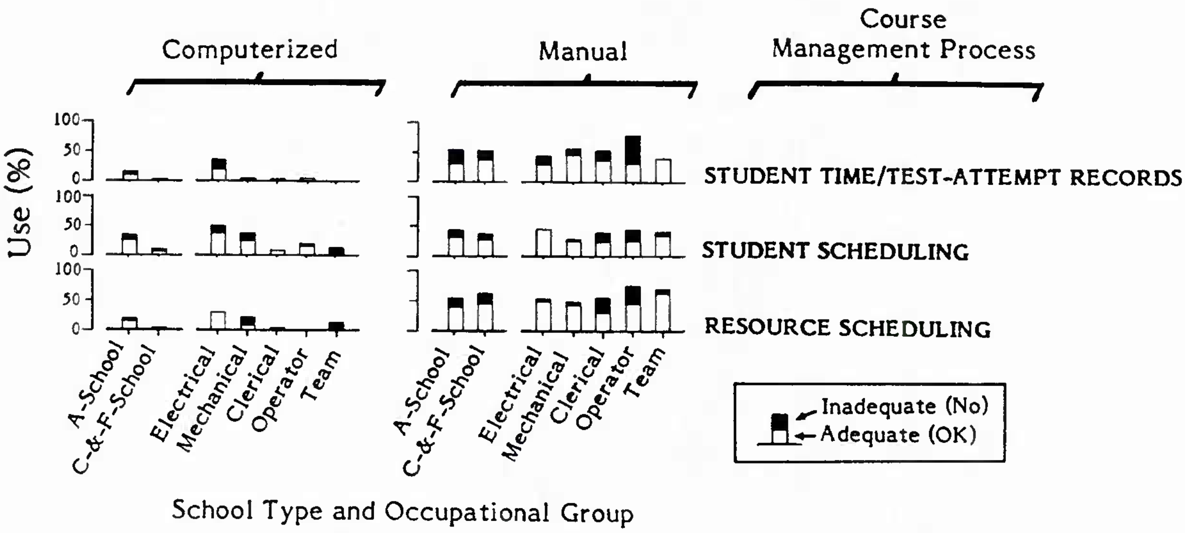

Figure 6. Use of course management processes by school type and occupational group.

The scheduling of students, instructors, classrooms, laboratories, materials, and equipment and maintaining an adequate supply of expendables is very complex and should be amenable to CMI. Courses required to generate many reports should be considered for CMI (e.g., equipment use, time, tracking of classified materials, dispensing supplies such as drugs or ammunition, etc.).

Management Documents

Course managers were asked to give the date of the latest revision of the various management documents associated with their course. The responses were divided into three groups--less than 3 years ago, 3 to 5 years ago, and more than 5 years ago. The response percentages on Table 12 do not include the not-applicable responses. The large percentages of not-applicable responses result from the course managers' lack of knowledge (e.g., before they were assigned to the duty station) or the fact that the document is not used in the conduct of the course. According to this measure, the curriculum outline is the document most commonly known about by the course managers.

Although the instructional systems development (ISD) process (Chief of Naval Technical Training, 1981) specifies the revision frequencies required for course documents, actual revisions of the surveyed courses vary considerably from the requirements. Courses which have recently undergone a full ISD revision may not be good candidates for major changes such as CBI unless an evaluation reveals deficiencies in effectiveness, a major problem such as instructor shortfall occurs, or very significant cost benefits.

Table 12

Course Management Documents: Revision Status

Document	Last Revision (%)			NA[a] Responses	
	Under 3 Years	3 to 5 Years	Over 5 Years	%	n
Project plan	59	38	3	42	57
Curriculum outline	55	36	9	16	21
Instructional management plan	76	22	1	47	63
Instructor guide	68	26	6	45	61
Instructional materials	69	26	5	44	59
Criterion referenced tests	72	22	7	45	61

Notes.

1. N = 135.
2. Response percentages computed without the not-applicable (NA) responses.
3. Response percentages may not always total 100 due to rounding.

[a]NA = not applicable.

DISCUSSION AND CONCLUSIONS

This assessment sought to identify patterns and problems in current instructional practices. Of particular concern was identifying where Navy training could be improved by using low-cost microcomputers as tools for management or instructional delivery.

Course Management

The lowest common denominator to all of the surveyed courses was their need for some general administrative/clerical computer support in registering, scheduling, tracking, score recording and general record keeping. These functions differ in how visible they are in the actual delivery of instruction.

One visible instance of CMI is guiding students through a course of study by directing them to specific study activities, testing at various points, and directing remediation. Another CMI situation is where a large central computer scores off-line tests and then provides students with prescriptive study assignments (e.g., in large scale Navy training operations such as those in Memphis, Great Lakes, Orlando, and San Diego). The

limitation of this CMI application is the student throughput and the resultant economic cost/benefit tradeoff.[6]

This survey found that 62 percent of the courses used tests for approximately 9 percent of the time for the general purpose of evaluating performance. More of these test methods were manual than were computerized, with computers used most for test scoring, analysis, and recording (15-16%). Pretesting and remediation prescription, which were the least used of the test methods surveyed, can be automated when instructional delivery is computerized. Testing functions in general offer great potenital for both computerized management and instruction. Specific benefits include having records of test attempts, time in tests, instruction time, automated scoring and tabulation, test development, test scoring, diagnostic analysis, and remediation prescription. These benefits are more attractive in situations with a high volume of students and stable curricula.

Course management also includes some more general support activities that often involve tedious clerical tasks such as scheduling of students, instructors, and other resources such as training equipment. The survey showed these functions were performed manually for 40 to 60 percent of the courses with another 28 to 36 percent wanting to add them because they currently did not exist at all. Other clerical tasks are maintaining equipment and material inventories, generating reports and keeping miscellaneous records (i.e., time equipment is used, classified materials, control of consumable supplies such as drugs or ammunition).

Currently, many instances of clerical support are most easily provided locally by using low cost microcomputers and widely available spreadsheet and word processor programs. There is no question about the usefulness of computers for course support, this is merely an extension of the general office automation trend in all parts of society. However, the proliferation of nonstandard hardware and software becomes an issue for many of these functions when documents or data must be shared. Standard spreadsheet/word processor programs might make life a little easier when these situations arise.[7]

Local or Navy-wide development will still be required for specialized programs not covered by the commercially available software. Software developed by Navy Personnel Research and Development Center (NAVPERSRANDCEN) for an existing UNIX[8] operating system provides some examples, such as a test formatting package for the Personnel

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[6] There is dissatisfaction with the current "Navy CMI" system (i.e., the test scoring system based on a mainframe computer at Chief, Naval Technical Training, Naval Air Station, Memphis). However, this satisfaction, we think, reflects the need to rework curricula, tests, and instructional delivery methods rather than the computer technology employed.

[7] Within the Navy, these programs seem to be those that are most popular in general civilian use. Although not related to training, the Naval Data Automation Command (NAVDAC) and their regional facilities (Naval Regional Data Automation Centers (NARDACs)) have been developing a set of programs called "BASIS." These programs provide some software standardization for uses such as making BOQ reservations, issuing car decals, and keeping on-board personnel counts. NARDAC (Norfolk, VA) also issues the very useful quarterly periodical Chips Ahoy to keep Navy microcomputer users abreast of new hardware, software, and procurement information.

[8] UNIX is a trademark of Bell Laboratories.

Performance Profile (PPP) tables, which the NAVSEA OD45519 ISD model requires (Bautista, Wetzel, & Wulfeck, 1985). Other examples are frequently used local forms such as a cost projection sheet that automatically totals entries (Lim, Wetzel, & Wulfeck, 1985) or milestone charts used in management documents (Wulfeck, McMichael, & Wetzel, 1985). These software packages grew out of a need to automate time consuming and technically demanding procedures on an existing computer. The authoring instructional materials (AIM) project at NAVPERSRANDCEN is currently developing similar software to automate ISD procedures for Navy activities responsible for curriculum development and guide the development process by capturing instructional development expertise.

A number of the results reported here simply document general background statistics. For example, differences in class sizes and student/instructor ratios generated little comment since they were all high enough to make effective individual treatment a problem. Increased instructor resources might be desired to achieve greater effectiveness but may not be available locally. Some increased effectiveness could result from selected CMI applications to reduce management and clerical tasks; selected CAI applications could also supplement direct instruction.

Instructional Delivery

Currently about 12.6 percent of all courses surveyed used some form of CBI (20% in A-schools and 5.6% in C-&-F-schools). Most of these were in electronics related schools (30%), where computer use was also generally greatest for other uses (e.g., test methods and scheduling). In assessing future interest, about 27 percent of the courses nominated at least one module as suitable for CBI. After support for course managers, the next ranked priorities for computer support included CBI applications.

Curriculum stability was cited as a special problem area by 39 percent of the course managers because revisions are often a natural consequence of updating courses to reflect newly implemented technologies. When training is packaged (as in CBI or video CBI) and is less dependent upon individual instructors, there is greater standardization and control over the quality of the instruction and its delivery. This feature becomes apparent when the instruction is to be delivered at many remote training sites.

Another problem related to the maintenance of course materials was the inadequacy of learning objectives, which 39 percent of the course managers cited. This reflects the need for a more systematic application of ISD principles. The computer per se will help in this area. Over time, maintenance of course computer files will enable revisions to be made faster and easier. The danger is, however, that the computer will simply produce poor objectives and poor training faster and easier. Efforts like the AIM project mentioned earlier, which is directed at quality improvement not just quantity, are therefore necessary.

The survey also identified a group of problems related to student ability and progress, which are areas for which selected computer applications might be adapted. We found 33 to 46 percent of the course managers reporting that students had problems with math and reading ability and entering skills and about 14 percent of the students did not reach criterion on the first attempt. About 36 percent of the managers wanted to track test attempts and another 21 percent were dissatisfied with their current tracking. Overall, the difference between fast and slow students completing a course was about 8 days; 53 percent of the managers reported pretesting was not applicable, and only 3 percent assigned special materials based on aptitude scores. All of these problems could be addressed by various forms of individual adaptation or remediation. Overall, pretesting (41%) and remediation prescription (48%) were the least frequently used testing methods.

These data indicate a major training deficiency that can only be met by some computer support or by an unlikely increase in instructors and facilities. In general, CBI is applicable in any situation calling for attention to individuals such as not being able to call a class together, the need to prescribe individual remediation, or scheduling difficulty. For example, the schedule of personnel aboard ship may limit the number of persons available for training in a given block of time to only a few or just one.

Costly training devices can act as bottlenecks when students have to spend substantial time waiting for access to limited quantities of laboratory equipment (Van Kekerix, Wulfeck, & Montague, 1982). Long waits for access to such equipment were cited by course managers in 20 percent of the A-schools, 25 percent of electrical schools and 10 to 15 percent of the remaining non-team occupation groups. Costly high fidelity laboratory training equipment could be supplemented with lower-cost microcomputer ancillary (auxiliary, supplemental, or subordinate) training devices. Ancillary trainers need not replace the high cost equipment; rather, only selected functions of the equipment need be simulated. For example, some aspects of equipment trouble shooting could be simulated by a microcomputer displaying oscilloscope patterns after inputing the labeled test points found on a printed schematic. Or, a videotape could introduce the equipment to be used in a laboratory. Ancillary trainers could allow students waiting for the higher fidelity trainer to be occupied more productively.

Course managers frequently cited learning objectives calling for simulation (63%) and drill and practice (54%). Remembering facts and use of procedures were found to be particularly frequent learning objectives in a related survey of Navy training courses,[9] which analyzed learning objectives in terms of the Instructional Quality Inventory classification scheme (Montague, Ellis, & Wulfeck, 1983). Taken together, such learning objectives can be addressed particularly well by CAI programs designed to provide drill and practice (remembering facts such as technical vocabulary or the information in large data bases) and the use of procedural steps (such as operating a piece of equipment). CAI can easily provide the most accepted usage of computers in today's teaching environment by providing the drill and practice of mathematical and language studies, which might be needed for the entering or basic skills. Such programs have been commonly available in the general world of education for quite some time and the nature of this curricula is not rapidly changing.

Many of the CAI applications suggested here involve some general formula for supervising the learning process. A typical CAI sequence involves presenting material for review or learning which may be followed by practicing the facts or procedures that are being acquired. Performance is assessed at various points to test for learning with feedback often provided. This assessment of the student performance is then compared to some criterion for the purpose of branching back to the original instruction or explanatory tracts tailored to the misunderstanding so that the learning criterion can be attained in later attempts. Computer interaction forces more active involvement than a lecture does since not paying attention may lengthen the student's study time. With conventional methods, branching within a training manual might have to include a prohibitively large number of explanatory tracks to accommodate differences among individuals. When instruction is individualized and not tied to a group, the instruction can be adjusted to the learner's own pace or skill level, which should include incentives to minimize dawdling. The general formula presented here does not refer to total self-pacing in a course, even with such incentives. The same techniques can also be used for enrichment, night study, remediation, laboratory management, etc.

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[9] Prepublication findings (C. D. Wetzel, D. L. Van Kekerix, & W. H. Wulfeck).

Additional enhancements to this basic adaptive feedback formula may be employed to simulate reality according to the specific training applications. Videodisc images or changeable high resolution graphics can illustrate complex principles not easily seen otherwise. Large data bases of information can be quickly accessed and traversed in a manner that facilitates the learning of otherwise disparate elements (e.g., compendiums such as the Jane's Fighting Ships 1985-86, 1986). Timing of responses and the possibility of using them for feedback during time dependent tasks in another qualitative feature (e.g., in equipment operator tasks). Simulations can represent a complex and even dangerous piece of equipment or demonstrate complex principles not easily illustrated with conventional methods or without recourse to the actual equipment. For example, the STEAMER project (Hollan, Hutchins, & Weitzman, 1984) represents a complex ship propulsion system in a manner that allows students to rapidly see the effects of making system adjustments.

The decision to computerize training raises questions about what improvements will be achieved over existing methods. It is easy to foresee improvements resulting from easing clerical or administrative tedium. Unless CAI provides some benefit, there is no point in simply feeding existing lessons into the computer merely to automate a book. Rather than computerizing entire curricula, a more rational path is to identify selected CAI applications that offer an improvement. Some already cited practical reasons for using CAI were to offer a learning capability not possible with conventional methods, reduce costs compared to high fidelity trainers, supplement instructor resources, standardize instruction over many sites, and provide onsite individual training.

Another practical reason in favor of CBI is that evaluations of such courses have shown training time to be reduced by about 30 percent (Orlansky & String, 1981). This finding is primarily due to individualization, since comparisons between individualized CBI and individualized conventional instruction found little time difference. A recent systematic review of previous CBI studies in secondary education also shows positive effects on student achievement (Bangert-Drowns, Kulik, & Kulik, 1985). A previous survey conducted to determine the extent of individualized instruction in 445 Navy A- and C-school courses found that 7 percent are either self-paced or CMI and 93 percent are group paced (Micheli & Ford, 1983). Computerized training is closely associated with individualized instruction, which may or may not involve self-pacing and controls over maintaining adequate student progress. Different implementations of self-paced instruction have experienced varying degrees of acceptance within the Navy (Thorstad, 1985).

Montague and Wulfeck (1984) argue that not all instruction is appropriate for CAI and that improvement of instruction through CAI will be a relatively slow and evolutionary process. The reasons cited for this are that (1) instructional quality is difficult to achieve regardless of the method of delivery, (2) computers as instructional tools are in a rudimentary state of development, (3) improvements in either instructional design or computer-based delivery will depend on fundamental changes in the scientific base (i.e., smarter programs, not just faster hardware), and (4) systematic planning for acquiring, standardizing, distributing, and incorporating proven instructional programs into schooling has not been done.

Computer-based Educational Software System (CBESS): Standardizing CBI Software

Many military training activities are buying computers that are often not compatible with one another. As a consequence, developing and sharing common software packages requires substantial recoding and duplication of effort (Dallman et al., 1983). As a partial solution, NAVPERSRANDCEN is standardizing CBI programs of previous practical utility

in Navy training through a contract with the University of Utah. The computer-based educational software system (CBESS) is a set of C-language programs intended to allow greater future portability as new computer technology developed (cf., Brandt, 1984). Portability refers to the input data or courseware as well as to the separate computer language in which the programs are written. Once developed, courseware should be able to be reused as new programs are adapted to other computers. Adaptation of the modularized computer program source code itself will require minor changes, but new computers may require rewriting a few low level "driver" routines, for new display devices for example.

CBESS consists of four major elements that can be used for many of the applications suggested by the present findings.

1. The Equipment Problem Solving Trainer (EPST) program is a two-dimensional video trainer/simulator designed to reduce reliance on the use of actual equipment trainers in learning to operate, maintain, and troubleshoot malfunctions.

2. The Computer-based Memorization System (CBMS) programs use a semantic network to represent large data bases of facts to be memorized through data-base browsing and games.

3. The Language Skills Computer-assisted Instruction (LSCAI) programs provide training in general and technical vocabulary and reading through exercises and games.

4. A general CBI package allows creation of textual, graphic, or video screens.

These programs generally operate in an author mode in which an instructional developer or subject matter expert enters new instruction and an instructional delivery mode in which the program interacts with students.

CBESS is intended to provide a systematic way to implement certain types of instruction in Navy training and should be considered a prototype for future standardization of relatively portable software libraries. Continuing effort is needed to develop guidelines for determining when CBI is appropriate and to develop aids for CBI authors to use to make quality CBI for their students. If a decision is being contemplated to computerize certain aspects of a course, then aids to guide the process would be useful. Such guidelines would address "when and what" instruction to computerize, as well as "how to" develop the instruction.[10] Kearsley (1983), for example, has provided a general handbook for the potential CBI developer. Developing CBI can take about 200 hours of development time for every hour of instruction implemented. Development includes making a feasibility study, a team effort encompassing both computerwise instructional and technical design expertise, and evaluation of effectiveness. Technical issues also

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[10]DoD is developing these guidelines: ASD Memorandum for ASA(M&RA), ASN(M&RA), and ASAF(MRA&I) dated 9 September 1985; Subject: Guidelines for the Development, Acquisition, and Use of Computer-based Instruction. The Navy is also developing such guidance (CNO letter Ser 116D/6U368509, dated 10 March 1986; Subject: Navy Computer-based Instruction (CBI) Guidelines). Some military guidelines can also be found in Military Standard MIL-STD 1472C (<u>Human Engineering Design Criteria for Military Systems, Equipment and Facilities</u>, 1981), but these do not specifically address instructional development.

arise concerning limitations of reliability and usability, hardware configuration and availability, transportability, and the features of the courseware authoring system. The acquisition of hardware through competitive procurement may also be complex. Large scale standard contractual arrangements such as the Air Force/Navy contracts (e.g., for Tempest certified computers) facilitate procurement for smaller development efforts.

RECOMMENDATIONS

The following recommendations are for the Navy education and training community:

1. Computer support should be provided for many administrative and clerical functions, such as scheduling, student tracking, and general record keeping. Student testing programs with a stable high volume would benefit from computerized test administration, scoring, recording, and tracking functions.

2. With recent initiatives to move training out of shore-based schools, training management, student record keeping, and certification testing will be more diffuse and difficult to manage in the future. Therefore, stand alone-computer tools on standard microcomputers should be developed for shipboard personnel to use in managing training.

3. CBI should be used for a number of specific applications. Using ancillary trainers for some laboratory situations would allow better utilization of student and instructor time when limited access to high cost trainers causes excessive waiting. Many students' entering skills (e.g., reading, mathematics, technical vocabulary) should be supplemented with commonly available CBI. Learning objectives involving drill and practice, simulation, remembering facts, and use of procedural steps occur frequently and are particularly amenable to computer-based instruction.

4. Continuing work should be supported to develop guidelines as to when CBI is appropriate and to develop aids for CBI authors so that they can develop quality CBI for their students.

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APPENDIX A

SURVEY QUESTIONNAIRE

SURVEY QUESTIONNAIRE

Survey Questionnaire As Administered

CIN Number ____________ Course Title ________________________________

Location ______________________________________

Place a mark in the (a) column if the answers to the following questions are YES. Mark the (b) column if the answers are NO.

		(a)	(b)
1.	Will the student use a computer on the job after completing this course		
	Do any of the following five areas present special problems in this course?		
2.	Adequate Learning Objectives	(a)	(b)
3.	Curriculum Stability	(a)	(b)
4.	Reading Ability	(a)	(b)
5.	Math Ability	(a)	(b)
6.	Entering Skills	(a)	(b)
	Do the learning objectives require any of the following:		
7.	Human Interaction	(a)	(b)
8.	Variable Responses	(a)	(b)
9.	Computer Utilization	(a)	(b)
10.	Simulation	(a)	(b)
11.	Extensive Drill and Practice	(a)	(b)
12.	Automated Cues and Prompts	(a)	(b)

Mark the (a) column if the process is computerized and judged adequate; the (b) column if the process is computerized and judged inadequate; the (c) column if the process is manual and judged adequate; the (d) column if the process is manual and judged inadequate.

What test processes are used in this course?

13.	Performance Evaluation	(a) (b) (c) (d)
14.	Pre-Testing	(a) (b) (c) (d)
15.	Unit/Module Tests	(a) (b) (c) (d)
16.	Summary/Final Tests	(a) (b) (c) (d)
17.	Remediation Prescription	(a) (b) (c) (d)
18.	Test Item Bank	(a) (b) (c) (d)
19.	Test Scoring	(a) (b) (c) (d)
20.	Test Analysis	(a) (b) (c) (d)
21.	Recording	(a) (b) (c) (d)

Which of the following course management processes are used?

22.	Student Time/Test Attempt Records	(a) (b) (c) (d)
23.	Student Scheduling	(a) (b) (c) (d)
24.	Resource Scheduling	(a) (b) (c) (d)

Mark the column corresponding to the statement selected below.

25. Which of the following statements best describes the distribution of student achievement in this course?

    (a) a few students above average, many about average, and a few below average. (a) (b) (c)

    (b) more above average than below average students.

    (c) more below average than above average students.

26. What is the average time required for a FAST student to complete this course? ______

27. What is the average time required for a SLOW student to complete this course? ______

28. How many modules are there in this course? ______

29. How many modules in this course use some form of computer-based instruction? ______

30. What computer equipment is used in managing or teaching this course? ______

31. What percent of the students reach criterion on module tests on the first attempt? ______

32. How many students are assigned to the average--

    a. Classroom ______

    b. Laboratory ______

33. How many instructors are assigned to the average--

    a. Classroom ______

    b. Laboratory ______

34. What is the average holding time in terms of number of working days for students waiting for this course to start? ______

35. Are students assigned special course materials based on aptitude scores? ______

36. If students are assigned special materials based on aptitude scores, what aptitude measures are used? ______

37. Estimate the percent of course time devoted to each of the following:

a. Lecture ________

b. Discussion ________

c. Demonstration ________

d. Self-study of reading materials in class ________

e. Tutoring ________

f. Films or Videotapes ________

g. Laboratory ________

h. Tests ________

i. Other ________

List Other ________________________________

38. What is the latest date for the following:

a. Project Plan ________

b. Curriculum Outline ________

c. Insructional Management Plan ________

d. Instructor Guide ________

e. Instructional Materials ________

f. Criterion Referenced Tests ________

39. What modules in this course should be considered a high priority for some application of computer assisted instruction? ________________________________

____

40. Is there a severe student "wait time" for access to equipment in lab courses? Yes _____ No _____

41. If yes, what modules and what is the nature of the problem?

____

____

42. If computer support was available for your school, what functions would have first priority ? ________________________________

____

APPENDIX B

SURVEYED COURSES

Surveyed Courses

CDP[a]	CIN[b]	Course Title
		Electrical Occupational Group
A-School		
601B	A1000010	Basic Electricity and Electronics
6274	A1000010	Basic Electricity and Electronics
604N	A1000060	Job Oriented Basic Skills (JOBS) Basic Skills--Electronics Strand 4
603V	A1000062	Electronics Technician (ET)
604E	A1000064	Electronics Technician Class A--Nuclear Field
6146	A1210142	Strategic Weapon System Electronic A
461X	A1210240	NATO SEASPARROW Guided Missile Fire Control System
603H	A1210482	Strategic Weapons Systems Electronics Math
6131	A1500025	Data Systems A School
1399	A1500051	USQ-20 Systems Maintenance
605Z	A6230105	Interior Communication Electrician A School
6070	A6620016	Electricians Mate (EM)
6219	C0002010	Aviation Fundamentals AT
6244	C1002010	Advanced First Team Avionics A-1
6241	C1002013	Avionics Technician Course Class A-1
6239	C1002013	Avionics Technician Course Class A-1
6515	C6022012	Avionics Electronics Mate Class A-1
C-&-F-Schools		
350T	A1000034	Miniature/Microminiature Electronic Repair (2M)
016C	A1020210	Electronics Warfare Tech/AN/SLQ-32
3427	A1600012	Cryptographic Equipment TSEC/KWR37 Maintenance
		Mechanical Occupational Group
A-School		
6400	A0410010	Gunner's Mate, Missile
6115	A0410010	Gunner's Mate, Gun
607X	A0410016	Gunner's Mate, Missile, Class A Phase II
607W	A0410016	Gunner's Mate, Missile, Class A Phase II
6278	A4950035	Hull Technician A School
6119	A4950035	Hull Technician A School
6262	A6510010	Propulsion Engineering Basics
6488	A6510079	Boiler Technician Advanced Operator
604M	A6510085	Job Oriented Basic Skills Engineering
6487	A6520018	Engineman Class A Course
610P	A6520244	Electricial Gas Turbine Systems Technician

[a]CDP = Course data processing number.

[b]CIN = Course identification number.

CDP[a]	CIN[b]	Course Title
		Mechanical Occupational Group (Continued)
6501	C6012010	Aviation Machinists Mate A-1
6516	C6022015	Aviation Structural Mechanic Safety Equipment
6517	C6022017	Aviation Structural Mechanic Hydraulic Course
6459	C6022025	Aviation Support Equipment Technician A-1
6518	C6032010	Aviation Structural Mechanic A-1
6506	C6462010	Aviation Ordnance A-1
6391	X7777771	Airman Apprentice Training Course
6396	X7777772	Seaman Apprentice
6399	X7777773	Fireman Apprentice
C-&-F-Schools		
0015	A4952037	Damage Control P-250 Pump Maintenance
8467	A6510065	Valve Maintenance
8469	A6510067	Pump Maintenance
034S	A6510068	Auxiliary Machinery Turbine Maintenance
8470	A6510069	Auxiliary Controls, Governors & Regulators Maintenance
016Y	A6510080	Boiler Technician Propulsion Plant Maintenance
3457	A6520019	Basic Engineman
530P	K0412048	Magazine Sprinkler System Operation, Maintenance & Repair
281B	K4952179	Foam Generating System Operation & Maintenance
		Clerical/Administrative Occupational Group
A-School		
6144	A2020014	Radioman A School Common Core
6102	A5000014	Personnelman Class A-1 School
528R	A5000025	Administration and Operation of Ships 3-M System
6057	A5100012	Yeoman A School
6059	A5510014	Storekeeper Class A School
6477	A8230012	Ship's Serviceman Class A School
056J	A9500062	Navy Prior Service Veterans Indoctrination Training
6522	C5512010	Aviation Storekeeper Course Class A
6528	C5552010	Aviation Maintenance Administration Course Class A-1
6511	X4444440	Navy Marine Typing Indoctrination
609E	X4444450	Basic Typing Cryptological
C-&-F-Schools		
3516	A0120011	Individualized Learning Supervisor, Track of Instruction, Basic
062M	A4950421	Basic Nuclear-biological-chemical Defense
0192	A 4C0014	Communications Security, Material System Custodian
3193	A5000011	Command Career Counselor Course
508U	A5000025	Administration and Operation of Ships 3-M System
2398	A5000028	Ships 3-M System Coordinator/Inspection Team Administration
2949	A5000028	Ships 3-M System Coordinator/Inspection Team Administration

[a]CDP = Course data processing number.

[b]CIN = Course identification number.

CDP[a]	CIN[b]b	Course Title
		Clerical/Administrative Occupational Group (Continued)
C-&-F-Schools		
030T	A5000033	Junior Petty Officer Leader, Management Education Training
029B	A5000034	Leader & Management Education Training
061P	A5000034	Leader & Management Education Training
2622	A 5F0011	Military Justice - Senior Officer - Fleet
8478	A6510064	Introduction to Engineering System Maintenance Principles & Practices
415N	A6520152	Introduction to Engineering System Maintenance
052A	A 7C0025	Leadership Management Education Training, Aviation Division Officer
062E	A 7C0027	Leader & Management Education Training Warrant Officers/Limited Duty Officers
333U	C5512012	Marine Aviation Supply System
079A	J2430970	Soviet Seapower
2291	J2430981	Enlisted Intelligence Assistant Course (EIAC)
9402	J 3A0951	Shipboard Intelligence Officer Course
509Q	J4950400	Damage Control Petty Officer
509L	J4950400	Damage Control Petty Officer
509L	J4950400	Damage Control Petty Officer
535X	K4932009	Unit Safety Supervisor
266L	K5002040	Career Information and Counseling
9552	K7C22135	Administration Personnel
268U	K8212142	Engineering Prouplsion Fuels & Oil, Shipboard Administration
531K	K8302120	Shore Patrol Orientation
523G	K8302122	Master at Arms (Afloat) Indoctrination
8994	X8888880	Specialized Briefing Training Senior Division Officers
		Operator Occupational Group
A-School		
604T	A1000059	JOBS Operator Course - Stand 2
608J	A1020209	Electronic Warfare Operations
602C	A1020209	Electronic Warfare Operations
6015	A1300037	Surface Antisubmarine Warfare (ASW) Operator
6540	A2210011	Operations Specialist A
6301	A2310044	Cryptologic Technician R
6302	A2310045	Non-Morse Basic Preparatory Operations
6320	A2310046	AN/GSO-76 (TEBO) Operations
601E	A2600030	Cryptologic Technician D
6065	A4500010	Music Basic
6167	A5310016	Data Processing Technician A School
6125	A8000013	Mess Management Specialist A Course
6537	C2102010	Aviation Antisubmarine Warfare Operator School A-1
6278	C2222010	Air Traffic Control

[a]CDP = Course data processing number.

[b]CIN = Course identification number.

CDP[a]	CIN[b]	Course Title
		Operator Occupational Group (Continued)
C-&-F-Schools		
3934	A0600025	Underway Replenishment Operator
5382	A2010022	Morse Code Operator
9320	A 4H0118	Surface Warfare Officer Basic
5066	J0410140	Small Arms, Expert Rifle
5184	J0600036	Boatswain Training
274E	J0620634	Basic Boat Coxswain
2883	J 2G0604	Rules of the Nautical Road
5292	J4950413	Shipboard Aircraft Fire Fighting Training
530B	K0602023	Pilot Rescue and Associated Water Survival
9334	K 2E2108	Safe Shiphandling
080K	K4952184	Foam Generating Systems Engineering Operator Personnel
274T	K6522157	Sewage Disposal System Operation and Maintenance
		Team Training
C-&-F-Schools		
075T	C2222017	CV Carrier Air Traffic Controller Team Training
8714	J1130170	NAV Gunfire Support MK 68 Team Training
2493	J2100513	Surface Ship ASW Attack Team Training
538P	J2210310	CIC Team Training
8747	J2210345	RADAR Naval Team Training
538Q	J2210357	Multi-threat
9305	J 2G0530	ASW Task Group Course
533E	J 2G0531	ASW Surface Unit Course
512Y	J4950412	General Shipboard Fire Fighting Training
509X	J4950412	General Shipboard Fire Fighting Training
509Z	J4950413	Shipboard Aircraft Fire Fighting Training
4555	J4590414	Air Capable Ship Helicopter Firefighting Team Training
274N	J4590414	Air Capable Ship Helicopter Firefighting Team Training
4554	J4950418	Shipboard Fire Fighting Team Training
510B	J4950418	Shipboard Fire Fighting Team Training
531J	K0602119	Underway Replenishment Simulator
204L	K0602136	Pilot Rescue Team Training
		Other Training
A-School		
609F	A3333330	Reading Remediation
601M	A9500061	Academic Remedial Training
C-&-F-Schools		
202C	J0000003	Overseas Homeported Ship Personnel Basic

[a]CDP = Course data processing number.

[b]CIN = Course identification number.

APPENDIX C

COURSES REPORTING THE USE OF COMPUTER-BASED INSTRUCTION

Courses Reporting the Use of Computer-based Instruction

CDP[a]	CIN[b]	Course Title	No. of Modules or Lessons
016C	A1020210	Electronics Warfare Technician/AN/SLW-32	20
075T	C2222017	CV Carrier Air Traffic Controller Team Training	5
601E	A2600030	Cryptologic Technician D	7
601M	A9500061	Academic Remedial Training	9
603V	A1000062	Electronics Technician (ET)	12
604E	A1000064	Electronics Technician Class A, Nuclear Field	11
6057	A5100012	Yeoman A School	12
608J	A1020209	Electronic Warfare Operations	31
6102	A5000014	Personnelman Class A-1 School	1
6219	C0002010	Aviation Fundamentals AT	3
6239	C1002013	Avionics Technician Course Class A-1	5
6241	C1002013	Avionics Technician Course Class A-1	5
6301	A2310044	Cryptological Technician R	1
6487	A6520018	Engineman Class A Course	16
6540	A2210011	Operations Specialist A	260
8747	J2210345	RADAR Naval Team Training	5
266L	K5002040	Career Information and Counseling	2

[a]CDP = Course data processing number.

[b]CIN = Course identification number.

APPENIDX D

SATISFACTION WITH EXISTING TEST METHODS AND
COURSE MANAGEMENT PROCESSES: ALTERNATE PRESENTATIONS

Table D-1

Test Methods Employed: Satisfaction and Dissatisfaction Recalculated

Test Methods Used	Test Method Employed (%)			
	Computer		Manual	
	OK	NO	OK	NO
Performance evalution	75.0	25.0	82.6	17.3
Pretesting	80.0	20.0	53.6	46.3
Unit/module tests	88.2	11.7	72.0	28.0
Summary/final tests	90.9	9.1	68.8	31.2
Remediation prescription	83.3	16.6	66.6	33.3
Test item bank	77.7	22.2	68.7	31.3
Test scroing	75.0	25.0	61.3	38.7
Test analysis	64.5	35.5	55.1	44.9
Recording	81.5	18.5	58.1	41.9

Notes.

1. Percentages obtained by dividing the Computer OK & NO response percentages in Table 7 by their sum. The same computation was performed separately for the Manual OK & NO response percentages in Table 7. These percentages were calculated so that readers could compare OK and NO response percentages for just computer or just manual method users.

2. Percentages do not always total 100 due to rounding.

3. N = 135.

Table D-2

Course Management Processes:
Satisfaction and Dissatisfaction Recalculated

Management Process Used	Responses (%)			
	Computer		Manual	
	OK	NO	OK	NO
Student time/test-attempt records	70.0	30.0	66.2	33.8
Student scheduling	70.9	29.1	75.9	24.1
Resource scheduling	60.0	40.0	72.8	27.2

Notes.

1. Percentages obtained by dividing the Computer OK & NO response percentages in Table 11 by their sum. The same computation was performed separately for the Manual OK & NO response percentages in Table 11. These percentages were calculated so that readers could compare OK and NO response percentages for just computer or just manual method users.

2. N = 135.

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